

S O U T H W E S T R E S E A R C H I N S T I T U T E
8500 Culebra Road, San Antonio 6, Texas

Department of Engineering Mechanics

PRESERVATION AND STORAGE
OF SOUND RECORDINGS

M. M. Lemcoe

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Prepared for

The Library of Congress
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Attn: Dr. Harold Spivacke
Chief, Music Division

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APPROVED:

C. H. W. Jr.
for Edward Wenk, Jr., Chairman
Department of Engineering
Mechanics

ABSTRACT

The principal aim of the investigation is to develop suitable techniques for storing and preserving the records of the Music Division of the Library of Congress.

This Progress Report summarizes Phase I project activities and accomplishments to February 1, 1958.

The report includes (a) a summary of Phase I exploratory testing on acetate discs, (b) an outline of proposed Phase II studies on acetate discs, (c) a description of the creep testing apparatus, (d) a description of the chemical exposure chamber, (e) a statement relating to literature studies being conducted by Southwest Research Institute and Dr. William Prager, and (f) a statement referring to the project conference to be held at Southwest Research Institute on March 3 and 4, 1958.

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I. INTRODUCTION

This is a study of the shelf aging of sound recordings, both discs and tapes, directed toward the establishment of optimum storage techniques and environments for preserving such sound recordings. The proposed program for this study was outlined in the Progress Report dated December 31, 1957.

The work done during this report period has been mainly confined to studies of "acetate" discs, and fabrication of test apparatus. Some exploratory tests have been made. Also, a brief literature search on vinyl plastic materials has been conducted and is virtually complete.

The "acetate" and "vinylite" record discs are so completely different in composition and response to degradation mechanisms, that the study of the two types of discs has been completely separated, both conceptually and in the laboratory. Probably, different storage techniques and environments will be recommended for these two different materials.

Substantial general information has been gleaned from the literature on the basic ingredients of both types of record materials, and on the parameters of shelf aging which result in disc deterioration. It will be necessary to establish the effect of these parameters on sound fidelity and to adapt certain standard testing procedures to measure the pertinent material properties.

Experimental progress has been delayed by lack of vinylite specimens for exploratory studies on this material and receipt

of a precise tilting level. The study of acetate records has been hampered by lack of knowledge of precise formulation of the material. (A contract extension in time, to cover these and other unavoidable delays, will be required.) Nevertheless, excellent progress has been made in determining the causes of degradation both from inspection of degraded records and the literature search.

II. WORK ACCOMPLISHMENTS AND PROJECT PLANNING DURING THE REPORT PERIOD

A. Acetate Records1. Exploratory Observations

The Library of Congress has furnished a disc cut in 1944 which is composed of nitrocellulose lacquer on a glass core and a number of new discs composed of nitrocellulose lacquer on aluminum cores. The lacquer coating of the old disc has cracked, shrunk, and peeled off of the glass core and is a good example of record deterioration. The new discs are being exposed to different environments in order to compare the relative significance of different degradation mechanisms. The mechanisms of degradation are considered to be as follows:

- a. Decomposition of cellulose nitrate.
- b. Loss of volatile residual solvents and plasticizer constituents.
- c. Loss of adhesion between lacquer coating and core.
- d. Anisotropic dimensional instability of coating.

Gross degradation did not result from oxygenation and heat below 140°F., either alone or combined, when the material was tested in the chemical exposure chamber, laboratory oven, and oxygen bomb. Minor embrittlement of the coating was observed at cut edges of the material, but this cannot be evaluated until quantitative

abrasion tests are made. Gross degradation was observed on exposure to sulphur dioxide and sunlight. This caused exudation of a wax from the lacquer coating, shrinking, brittleness, and loss of adhesion to core, much as was observed on the old record. Currently in progress are tests of the effects of cycling humidity and temperatures on the coating and of fungus attack.

Sufficient information on the constituents in acetate discs is still lacking. However, cellulose nitrate, which is one of the principal constituents of acetate discs, has been extensively studied and much of the information from these studies is directly applicable to the problem at hand. In the interests of time, it is therefore proposed to proceed into the Phase II part of the acetate disc studies on the basis of information which is now available, and come back at a later date to complete the remaining portion of the Phase I study involving the other constituents found in acetate discs.

2. Proposed Study Outline for Phase II for Acetate Discs

The parameters to be measured are:

- a. Decomposition of cellulose nitrate by ASTM rate of reaction time at 134.5°C .
- b. Brittleness by loss of material on abrasion.
- c. Adhesion of coating to base in terms of force required to strip coating from base.

- d. Change in playback fidelity, before and after exposure, on the basis of electronic measurements.

The accelerated aging techniques will consist of:

- a. Temperature cycling.
- b. Humidity cycling.
- c. Exposure to ultra-violet light and sulphur dioxide.
- d. Use of elevated temperature and high concentrations of oxygen.

The information desired from these tests is:

- a. The effects of humidity and temperature and rapid environmental changes on acetate discs to determine the optimum environmental conditions for storage and use.
- b. Methods of reconditioning and the value of restoratives in storage containers to inhibit brittleness.
- c. The value of protective coatings, surface treatments, and envelopes.
- d. The expansion and contraction of coating and effects of non-uniformity of coating materials.
- e. The character of decomposition products given off during aging.
- f. The loss of adhesion of coating to base.

g. The loss of volatile residual solvents and plasticizer constituents.

h. The effects of fungi on the records.

B. The Design and Fabrication of Test Apparatus

1. Fabrication and calibration of creep testing apparatus has been completed. Constant loads are applied to the specimens by means of dead weights. Fig. 1 shows the apparatus with the insulating chamber lifted part way off the fixture base plate. It should be noted that up to five records can be accommodated in horizontal loading configurations. Thus, it is possible to conduct, simultaneously, up to five creep deformation-time tests, at different stress levels, under the same temperature-humidity environments. Humidity is controlled with a large evaporating dish containing aqueous solutions and it is monitored by Minneapolis-Honeywell humidity-sensing elements. Temperature is controlled by a circulating diffuse heated air system and tubular heaters attached to the insulating chamber walls which are monitored by a Leeds-Northrup recorder-controller, used in conjunction with copper-constantan thermocouples. The air circulating fan and motor are separate from the fixture and are connected to the base plate by flexible conduit in order to prevent any possible vibration of the specimens. Preliminary temperature distribution measurements indicated a linear temperature distribution within the chamber with a 1° F. temperature

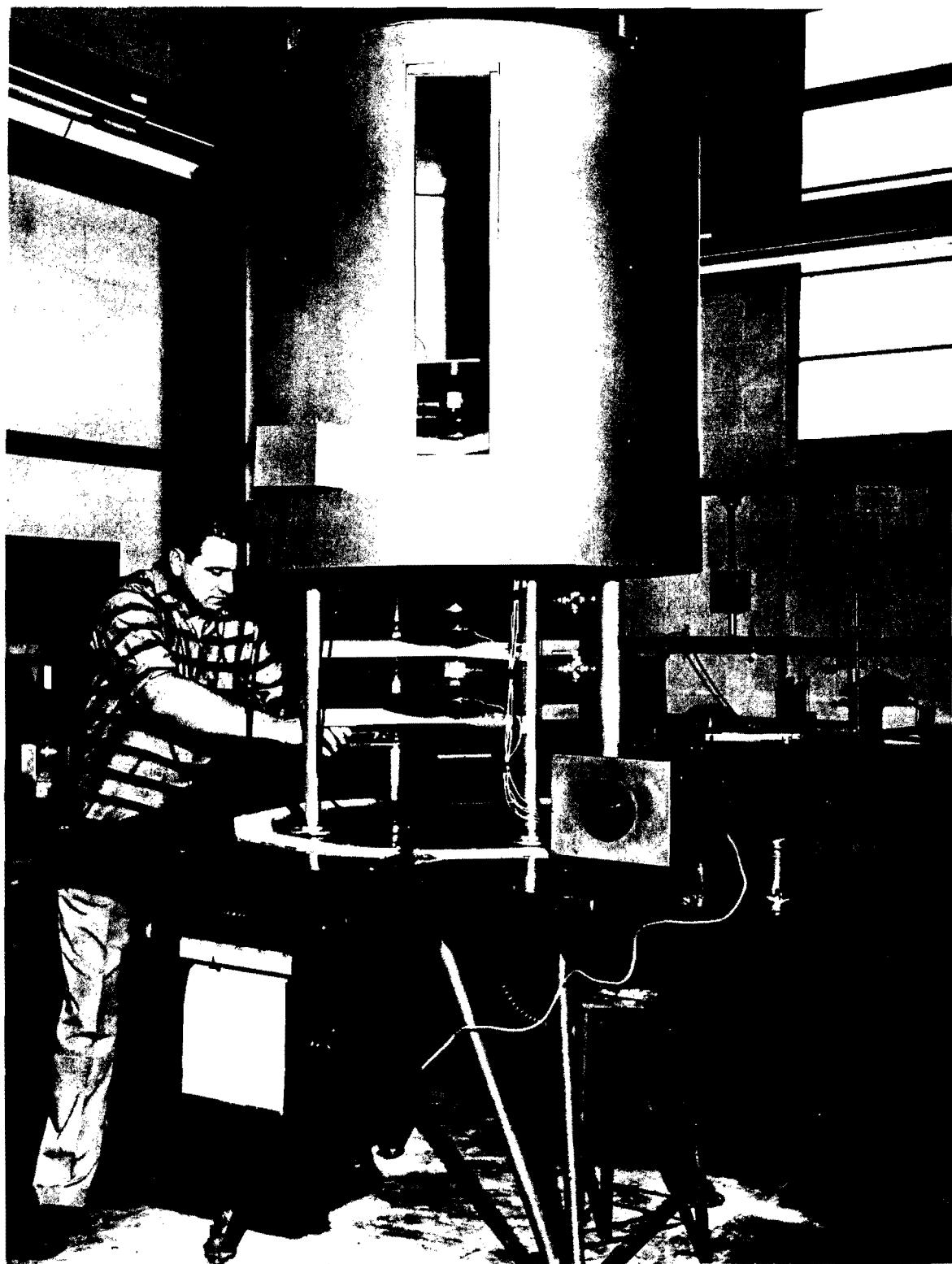


Fig. 1 Creep Testing Apparatus During Temperature Calibration

difference between each record at 150°F., which is the maximum anticipated test temperature. The recorder-controller used proved to be too insensitive to allow closer control, and so it has been modified to permit even closer adjustment of temperature distribution. It is anticipated that the maximum temperature difference will not exceed 1°F anywhere, at the maximum test temperatures. The apparatus will probably operate over a temperature range of from ambient to 150°F. Measurements of deflection with the blower system off, will be made with a precise tilting level equipped with an optical micrometer attachment which permits measurement directly to 0.001 inch. Such an instrument has been borrowed from Kelly Air Force Base on temporary loan and found to be very satisfactory.

2. The chemical exposure chamber shown in Fig. 2 has been used for Phase I testing of acetate records and is currently being used to provide proper environment for growth of fungi on specimens. It consists of a plexiglas chamber, sealed with rubber gasket material, in which is mounted a small fan for air circulation, with glass bubblers at inlet and outlet to serve as valves and measuring devices, a gas diffusion flask, and flexible tubing connections to source of gas and exterior exhaust vent. This apparatus is designed to accommodate six records. This apparatus is used in conjunction with a standard oxygen bomb unit and an oven.

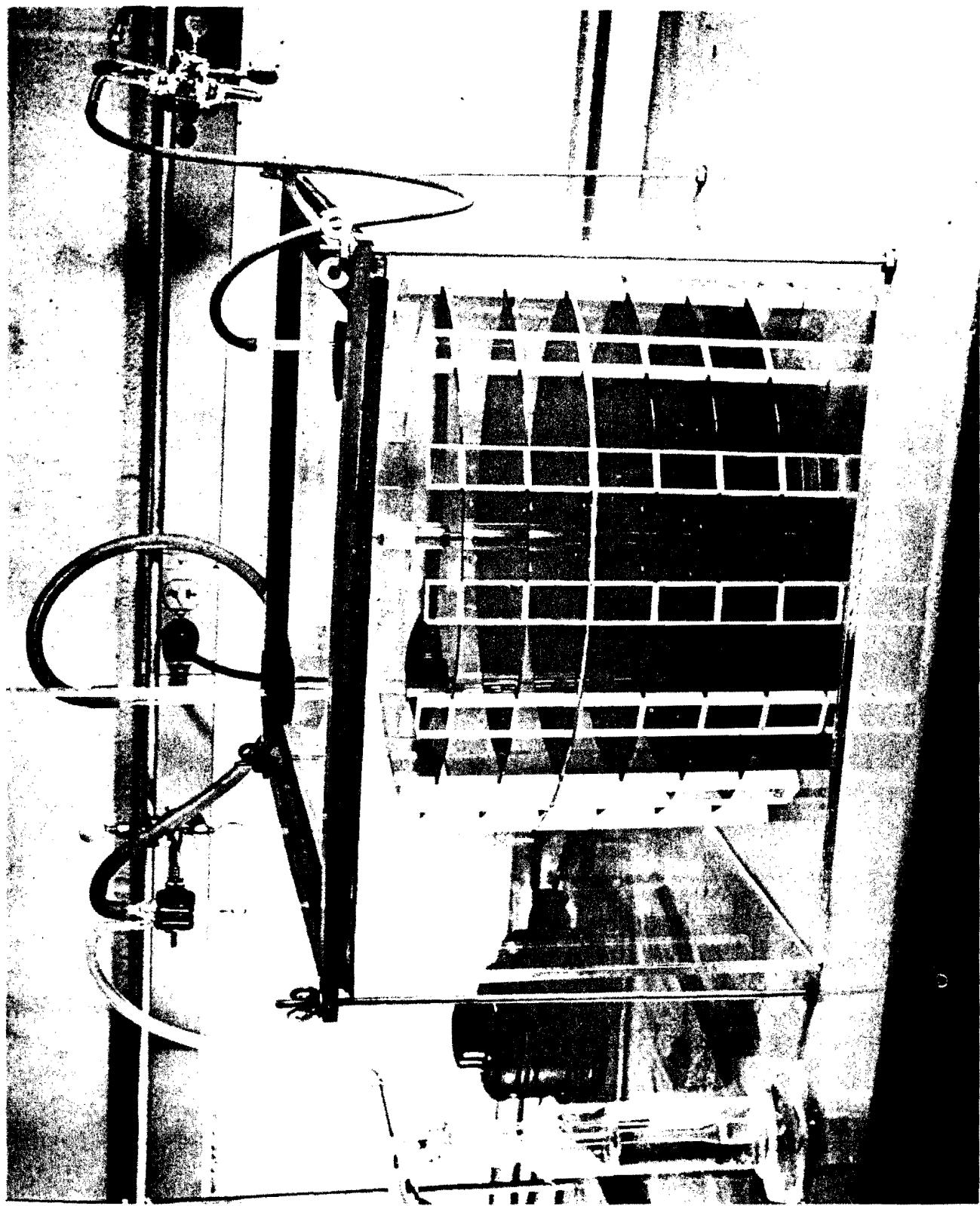


Fig. 2 Chemical Exposure Chamber

C. Literature Search

Dr. Roy McCutchan, of the Chemistry and Chemical Engineering Department, is completing an evaluation of a number of pertinent references in order to develop feasible techniques for correlation of heat aging to accelerated aging techniques and to devise means of measuring the pertinent properties of the plastic materials in this study. Considerable information of benefit has been developed by the literature search and polyvinyl chloride and vinyl chloride polymers have been extensively studied.

Under Dr. Prager's direction a literature study is also being conducted. It is hoped that one of the results of this study will be recommendations as to the best analytical theory for predicting the effects of long-term warp and creep in the various stress fields associated with vertical or horizontal edge and spiral storage on the basis of short-time creep testing. It will begin immediately on receipt of the precise testing equipment which Dr. Spivack is endeavoring to procure from the Defense Air Force Base Depot.

D. Miscellaneous

A temporary dust proof trailer with shelves has been constructed to store incoming material and the playback equipment, all of which has been received. It is being set up and checked out, prior to project use.

III. PENDING CONFERENCE

A project conference at Southwest Research Institute will be held on March 3 and 4, 1958, to review activities and accomplishments to date and discuss future plans. Drs. Spivacke and Prager, in addition to key Institute project staff, will attend.

IV. FISCAL AND CONTRACTUAL MATTERS

Project expenditures to February 1, 1958, total approximately \$13,300.

In the previous Progress Report, dated December 31, 1957, it was estimated that Phase I would be completed by the end of March, 1958, assuming receipt of the vinyl records within three to four weeks. On February 6, 1958, the writer learned from Dr. Harold Spivacke that it would still be two to three weeks before we would receive any vinyl records. On this basis, it is now estimated that Phase I should be completed by the end of the third or fourth week in April, 1958.

The exact contract extension in time required because of this and other possible unavoidable delays cannot be determined until the status of the following items is ascertained:

- (a) The availability of a precise tilting level being requested through the Library of Congress from the Topeka Air Force Depot, or other government sources.
- (b) How long it will be before information or results are available from the Questionnaire which is now being circulated.
- (c) Whether the manufacturer of the acetate discs now being tested will reveal the composition of these discs. It should be noted that Dr. Spivacke is making every effort to obtain this information, but difficulties may be encountered because of proprietary considerations.
- (d) Receipt of the air analysis data which is being accumulated by the Library of Congress.